nograph. His object was to ascertain the shapes of the indentations made by different known sounds. The vowels and diphthongs were spoken into the mouthpiece of the apparatus with small panels in the order seen on the diagram.

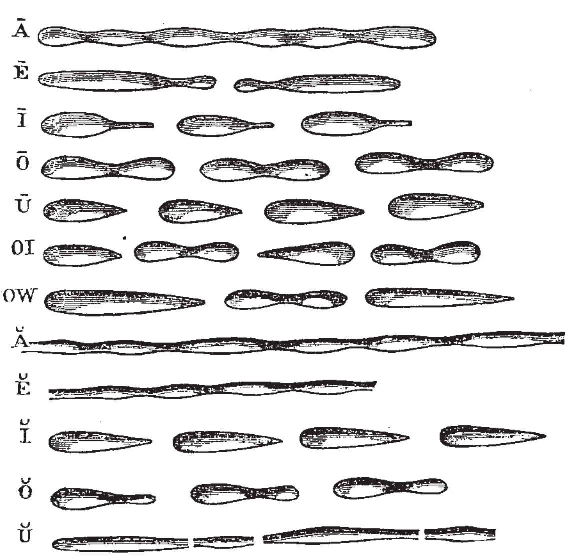
These sounds were repeated thrice on each of three foils. They were then mounted on glass plates, separated, and labelled. Finally, they were cut out and mounted on another piece of glass vertically, instead of horizontally, in order that a number of the dents produced by any given sound might be on the screen at once.

Lissajous, Leon Scott, and König have provided the means of transforming sounds into form, in various ways, viz., by bright points on the ends of steel bars of different thicknesses; by vibrating membranes at the extremity of a "phonautograph," and by flames reflected in a rotating mirror. It was natural to conclude that the same vibrations, imparted to a steel point by means of a metal diaphragm, would leave an equally characteristic trace.

The same voice (that of Dr. Plush), speaking the following vowels and diphthongs as nearly as possible at the same distance from the mouthpiece, was relied upon for the matrices.

The first records tried, to ascertain whether the pronunciation was perfect, were afterwards thrown away, and the records which were studied were not in any way injured by a second passage of the point of the stylus.

By following along the nearly vertical line of impressions, which are at the same time in focus, it will be observed that this line consists of one long followed by two shorts (or two shorts followed by one long), the indentations bearing a general resemblance to each other and to seeds. This is long A, or "Ah." A glance at



[NOTE.—In the wood-cut, the forms made by the excursions of the stylus for the short letters are wider than they should be.]

short ă (as in "bat"), will show the same thing, but the seed-shaped hollows are narrower, and there are no abrupt terminations of the hollows by intervening parts of the foil, which have not been touched by the needle-point.

Ē (or ay), on the screen, looked like the magnets of two Bell telephones, with the small ends turned towards each other. In the diagram they look like two Indian clubs with the handles together. The same general resemblance is observed in E short, except that, as in ă short, the volume of sound being less, the intensity was less, or (what is the measure of intensity) the path of the needle-point was shorter, and it seldom entirely cleared the foil, the consequence being a continuous groove of irregular, but normally irregular, width.

Ī and Ĭ are much alike in general form, as also are Ō and Ŏ, the coupling of the pairs of the latter being the most striking feature. Ū and Ŭ, in the drawing, best show the difference in shape produced by less intensities, the short being drawn out, and more acicular.

OI is very interesting. The diphthong consists of ŎĬ, and the very moulds which characterise their sounds are to be observed in the cut.

OW presents a composite character, but its derivation has not yet been made out.

The above presentation of the subject is necessarily crude and imperfect, but will illustrate the possibilities of an exhaustive investigation.

THE LIFE-HISTORY OF A SEPTIC ORGANISM[1]

THIS was an account of a hitherto unrecorded organism, belonging to the septic series, which was found in the earlier stages of the decomposition of the macerating body of a vole. It was studied by the aid of the "continuous stage" used by the author and Dr. Drysdale in their "Researches on the Life History of the Monads,"[2] by means of which a drop of the septic fluid containing the organism can be kept under examination for an indefinite time, without evaporation; and be studied with the most delicate and powerful lenses. The method pursued was continuous study, first of the details of the several metamorphoses, and by the light thus gained, a continuous study, subsequently, of their sequences in the same individual form.

The majority of the most difficult and delicate work was done with a new $\frac{1}{35}$-inch lens, made for the author, with a special view to this class of observation, by Messrs. Powell and Lealand. He also had the advantage of the fine "new formula" lenses, made by the same firm recently, that is to say, two $\frac{1}{8}$ths, a $\frac{1}{12}$th, and a $\frac{1}{16}$th. He also used their $\frac{1}{25}$th and $\frac{1}{50}$th inch objectives.

The organism never exceeds the $\frac{1}{4000}$th of an inch in long diameter: it is oval, with a constriction slightly in front of its short diameter: and at its anterior extremity has a head-like protrusion, to which is attached a long delicate flagellum. At the sides of the shorter, or front segment of the oval, somewhat in the position of "shoulders," two long fine flagella proceed, and as a rule trail with exquisite grace behind; one on either side. It swims with great rapidity and has every variety of motion in the fluid: and in the accomplishment of its evolutions its lateral flagella are largely concerned. But besides its swimming power, it has the capacity to anchor both its trailing flagella to the floor, or the stage, or to a decomposing mass, and by coiling these flagella, and bringing itself down upon the body to which it is anchored, and then suddenly darting up so as to make its flagella, together, the radius of a circle, it darts down on the decomposing substance, and by the enormous numbers that are constantly doing it, aids in the rapid breaking up of the tissues.

By steadily following it in the free-swimming condition it was seen to undergo fission or self-division, which was a very complex and extremely delicate process; the division beginning in the front flagellum and proceeding until, by longitudinal division, a new lateral flagellum was, in the act of self-division, made for each half; and by the snapping of this both halves went free as perfect organisms, soon to commence the process again. A great deal of close and careful detail was given of this process, and was accompanied by illustrations drawn from nature. There were also accounts of a series of

[1] Abstract of Paper read before the Royal Society on the Life-History of a Minute Septic Organism: with an Account of Experiments made to determine its Thermal Death Point. By the Rev. W. H. Dallinger, F.R.M.S.

[2] *M. M. J.*, vol. xi. pp. 97—99.

observations on the frequency of the recurrence of the process of fission, by the continual following of one segmental product of the act; and also from its beginning to its cessation, in a series of separate organisms, making manifest the periods of greatest fissional intensity; and also showing the result following on the cessation of fission. In the majority of cases it was an exhaustion of vital action and death: but in a certain proportion, in which fission was not so long continued, it was a rapid change to an amœboid condition, resulting in the absorption or fusing of the lateral flagella with the body, and a change of form; the organism becoming now quite oval and having only an anterior flagellum. It swims easily, but has lost all the power and freedom of motion possessed before, moving only in a straight line. But it soon comes into contact with a colony of the organism in the springing condition, attaches itself to one of them, which then soon unanchors and both swim away. In the course of time their movements become sluggish; the sarcode of the bodies is palpably blending, they become quite still, except for amœboid movements, and then become one mass, oval in form, which elongates into a spindle-shape, remaining motionless and still in all respects for three or four hours; when, as was ultimately, and by long continued effort made out, it pours out exquisitely minute, opaque, apparently round specks, which, when carefully and steadily followed with the best appliances, were seen to develop into the adult form and size.

The author then desired to discover the relative heat-resisting power of the perfect form, and the germ or spore. The adult forms were proved by a very direct method, which was fully detailed, to be wholly destroyed at a temperature of 142° F. Two methods of heating were employed to test the resistance of the spore. One was the "dry" method which had been employed in the former researches; but which was somewhat modified and used with special precautions; and the result of an elaborate series of experiments proved, that by this mode of heating, the spore could resist a temperature of 250° F.

It was next determined to test the heat resistance of the spore when they suffered the heat, diffused in a fluid. The difficulty of accomplishing this, so as to secure an unmistakable result was carefully pointed out and dwelt on; and the opinion recently expressed by Dr. Bastian that it was "perfectly easy" shown to be an error.

The apparatus employed for the purpose was specially delicate, but enabled the author to test directly the results of heat on the spores as well as on the adult organism, without exposure after the vessel was once sealed. The form used was specially devised for these observations. The temperatures up to the boiling point of water were got in melted paraffin, and higher temperatures in a digester. The result was that 220° F. was found to be the limit of temperature which the spore of this organism could endure without destruction of vitality. That is to say 30° F. lower than the same spores could bear in a "dry" heat. But it was pointed out, that to endure this temperature, implied protection of some kind: but that this in the *undeveloping* germ, was not only capable of being understood, but would doubtless prove of immense value to the organism.

OUR ASTRONOMICAL COLUMN

THE UNIVERSITY OBSERVATORY, OXFORD.—Prof. Pritchard has published No. 1 of *Astronomical Observations made at the University Observatory, Oxford.* It comprises observations made between the autumn of 1875, when the establishment was first organised, and the end of 1877. They relate to the satellites of Saturn, double stars, and the five comets discovered in 1877, by Borrelly, Winnecke, Swift, Coggia, and Tempel, for which provisional elements and, in the case of Winnecke's comet, an extensive ephemeris are added; also elements of the orbits of ξ Ursæ Majoris, 70 Ophiuchi, and μ^2 Boötis, and comparison of the same with the interpolation curve drawn according to the method of Sir J. Herschel. The observations of the satellites of Saturn consist of differences of R.A. and N.P.D. from the centre of the primary, facilitated by the ephemerides which Mr. Marth has regularly supplied; together with the other observations now printed, they have been made with the refractor of 12¼-inches aperture, constructed for the observatory by Mr. Howard Grubb, of Dublin, Mr. W. E. Plummer, the first assistant, being credited with the greater part of them. In addition to the above work, it is mentioned that nearly twelve hundred measurable photographs have been secured by means of Dr. De la Rue's reflector, which he presented to the Observatory, and which is mounted in the eastern dome, and a very beautiful instrument for completing the measurement of these photographs has been recently received through the liberality of the same gentleman. The institution is under the control of a Board of Visitors, as usual in so many of the more important astronomical establishments at the present day, the Board being composed of the Vice-Chancellor, the Proctors, the Astronomer-Royal, the Director of the Cambridge Observatory, the Radcliffe Observer, and four other members elected by the Convocation of the University; these members are at present, Dr. De la Rue, Prof. Bartholomew Price, J. A. Dale, M.A., and W. Esson, M.A.

The position of the University Observatory is in latitude 51° 45′ 34″·15, and longitude 5m. 0·40s. west of Greenwich.

THE CINCINNATI OBSERVATORY.—No. 4 of the publications of this observatory, just issued, contains the results of measures of double stars made in the year 1877, with the 11-inch refractor, the object-glass of which was replaced early in the year after having been successfully refigured by Alvan Clark and Sons; in addition to this improvement a new driving clock was added. The stars measured are, with very few exceptions, situate between the equator and 40° of south declination, and this selection of objects gives a rather special value to the Cincinnati observations, though it has been notified from Melbourne that the remeasurement of Sir John Herschel's southern stars is in progress there. The methods of observing at Cincinnati, and the investigation of personal equation, are explained in the introduction, and the larger differences in the measured angles and distances, found on comparison with the catalogues of Struve, Sir John Herschel, Jacob (Poona), and Dembowski's measures of doubles discovered by Mr. Burnham, are indicated. Some of these larger differences occur in the case of well-known rapidly-moving binaries; but there are others which deserve further attention, to decide upon the cause of the observed changes. The following may be mentioned:—

Star.	Sir J. Herschel's Measures.	Pos.	Dist.	Cincinnati Measures.	Pos.	Dist.
		°	″		°	″
h 2036	1836·54...	40·4	—	1877·76...	25·1	1·40
Lalande...2416	36·96...	—	1·82			
h 3447	1837·11...	75·5	—	1877·80...	90·1	2·20
Lacaille ...462	37·51...	—	3·12			
h 3461	1836·54...	69·6	—	1877·85...	59·0	4·84
ε Sculptoris ...	36·70...	—	5·53			

Of stars observed by Sir J. Herschel with the 20-feet reflector, for Nos. 2,904, 3,494, and 5,113 (which are respectively Lacaille 8,262, 702, and 8,098), the Cincinnati measures show differences greater than 20°. The positions of these stars for 1880 are:—